Phalaris arundinacea L.

Photo : R. Pankevičius

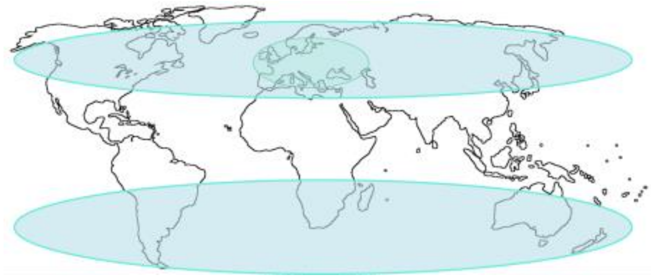
Photo : R. Old

Photo : B. Hattaway

Photo : L. J. Mehrhoff

Origin and diffusion

Origin: native to Europe, some authors view it as native to Asia and North America as well.
Distribution: temperate areas of the world
Invasive potential: high, because of its tenacity and rapid growth



Introduction

Reed canary grass is a vigorous cool season herb growing as a perennial from scaly creeping rhizomes; it forms dense, highly productive monocultures that spread radially in wetland ecosystems. Around the hollow and erect stems numerous broad leaves develop, mainly at the base. *P. arundinacea* is morphologically variable, and more than ten intraspecific categories have been described.

It can be used for erosion control along stream banks, shorelines and waterways or planted for forage; it is well suited to create filter barriers which intercept wastewater from industries, sewage treatments or cultivated fields. *P. arundinacea* has been recently considered for energy use, as commercial energy crop.

Synonyms: *Phalaroides arundinacea* L. Raeusch.

Common names: reed canary grass, gardener's-garters (English); saggina spagnola (Italian).

Description

Life-form and periodicity: perennial herb

Height: 60-170 cm

Fam. *Poaceae*

Description

Roots habit: extensive, rhizomatous root system. The rhizomes are stout, long, and scaly. New rhizomes originate almost entirely below the soil surface from buds at the nodes of other rhizomes. Roots and rhizomes may form an almost impenetrable sod.

Culm/Stem/Trunk: the stem is sturdy and hollow with some reddish coloring in the upper part.

Leaf: leaf blades are usually green, but may be variegated. They are flat, glabrous and taper gradually, 30-45 cm long and 1,2 cm wide.

Rate of transpiration: 4,2 - 9,2 mm/day

Reproductive structure: flowers are arranged in dense, branched panicles that can exceed 5-20 cm in length. Immature panicles are compact and resemble spikes, but open and become slightly spreading at anthesis. Spikelets are lanceolate, 5 mm long and pale.

Propagative structure: the fruit is a caryopsis, 1,5 to 4 mm long and from 0,7 to 1,5 mm wide containing a single seed.

Development

Sexual propagation: it produces large quantities of pollen and is typically cross-pollinated. It is wind pollinated. The seed is passively dispersed by gravity and germinate immediately after ripening; it has a short storage life and there are no known dormancy requirements.

Asexual propagation: it spreads by creeping rhizomes. Rapid vegetative spread rate.

Growth rate: rapid

Habitat characteristics

Light and water requirements: it requires full sun or partial shade and it prefers moist habitat.

Soil requirements: it is adapted to normal, clayish and sandy soils. Well suited to wet soils that are poorly drained or subject to flooding.

Tolerance/sensitivity: it has excellent frost tolerance and it also has good drought tolerance. It survives prolonged flooding by possessing anoxia tolerant rhizomes; once established, it can withstand continuous inundation for 60 to 70 days.

Phytotechnologies applications

P. arundinacea contributes a number of desirable attributes for restoration of degraded ecosystem such as limiting soil erosion, improving water quality, having lower agricultural chemical and nutrient requirements, and increasing the organic matter content of the soil.

These plants are not hyperaccumulators of **heavy metals** and, once absorbed by roots, the mobility and translocation of the metals is limited, especially in the case of **Co** and **Cd** (Polechońska & Klink, 2014); however, they are fast growing and high-biomass producers, have a deep root apparatus and can tolerate a range of heavy metals in their tissues. Given this, they are often utilized to stabilize the metals in soils, sediments and waters, in both natural and constructed wetlands (Bragato *et al.,* 2008). The significant, positive correlations found between the content of **Co** and **Zn** in the environment and the levels of these elements in the organs of the reed canary grass indicate potential application of *P. arundinacea* in the biomonitoring of environmental contamination with these metals (Polechońska & Klink, 2014).

Canarygrass was also evaluated for its abilities to stimulate dissipation of **PCB**, **TNT**, and pyrene in soil and it was found to be effective in enhancing TNT and PCB transformation, mostly in low organic matter content soils (Dzantor *et al.*, 2000; Chekol *et al.,* 2002; Chekol *et al.*, 2004). This grass species showed also high tolerance to **chemicals from the petrol- and coal-processing** industries (phenol and phenanthrene); it was even observed that low contaminant concentration (about 50 mg/l in case of phenol) stimulated the plant growth (Hübner et al., 2000).

Being one of the highest-yielding cool-season grasses, it can be potentially used as biofuel (Wrobel C. *et al*., 2009).

Experimental studies

-Experiment 1-

Reference	Polechońska, L., & Klink, A. (2014). Trace metal bioindication and phytoremediation potentialities of Phalaris arundinacea L.(reed canary grass). Journal of Geochemical Exploration, 146, 27-33.
Contaminants of concern	Zn, Mn, Fe, Pb, Cu, Ni, Cd, Co and Cr
Mechanism involved in phytoremediation: Phytostabilisation/rhizodegradation/phytoaccumulation/phytodegradation/phytovolatilization/ hydraulic control/ tolerant	Phytostabilisation and phytoaccumulation

Phytotechnologies applications

Requirements for phytoremediation (specific nutrients, addition of oxygen)	Not reported in the publication
Substrate characteristics	The water pH ranged between 7.7 and 8.7 which can be considered normal for surface waters; however in study sites in dam reservoirs it was significantly higher than in other localizations and reached 11.2. The water electrical conductivity ranged between 190 and 390 µS/cm and corresponded with conductivity of most freshwater ecosystems. The pH of bottom sediments was close to neutral and ranged between 6.58 and 7.93.
Laboratory/field experiment	Field experiment: samples of water, bottom sediments and vegetal tissues of P. arundinacea were collected in twenty-one study sites along the in the Bystrzyca River (Poland).
Initial contaminant concentration	Metal concentrations in water: according to the values established for dissolved elements in clean surface water, most study sites in the river exceeded the upper limits for Zn, Cu, Pb, Ni, Co and Cr. Metal concentrations in the bottom river sediments: concentrations were mostly within the ranges typical of European background values, except for Zn, Ni and Cu whose values were above the background concentrations in most study.
Post-experiment plant condition	The river vegetation was very poor. Only a broad belt of emergent vegetation, dominated by *P. arundinacea,* surrounded the riverbank zone.
Contaminant storage sites in the plant and contaminant concentrations in tissues (root, shoot, leaves, no storage)	The content of all examined metals was the highest in the roots of P. arundinacea and decreased in the following order: roots > leaves > stems. Translocation factors for all trace elements analyzed in P. arundinacea were below unity confirming high root retention capacity for the elements and low intensity of their transfer to other plant organs The mean value of elements Bioconcentration Factor (BF) increased in the following order: Pb < Fe < Cr < Ni < Cu < Mn < Zn < Co < Cd. For the majority of trace elements BF was lower than unity. The significant positive correlations found between the content of Co and Zn in the environment and the levels of these elements in the organs of P. arundinacea indicate the potential use of the species studied in the biomonitoring of environmental contamination with these metals

Phytotechnologies applications

-Experiment 2-

Reference	Chekol, T., Vough, L. R., & Chaney, R. L. (2004). Phytoremediation of polychlorinated biphenyl-contaminated soils: the rhizosphere effect. Environment international, 30(6), 799-804.
Contaminants of concern	Aroclor 1248 (PCB mixture)
Mechanism involved in phytoremediation: Phytostabilisation/rhizodegradation/phytoaccumulation/phytodegradation/phytovolatilization/ hydraulic control/ tolerant	rhizodegradation
Types of microorganisms associated with the plant	Bacteria and fungi
Requirements for phytoremediation (specific nutrients, addition of oxygen)	Not reported in the publication
Laboratory/field experiment	Laboratory experiment: it was conducted in growth chamber. The experiment was divided in two sets. The first phase of the trials involved crop species screening, while the second phase were evaluated for their rhizosphere characteristics under irradiated and unirradiated soil conditions.
Substrate characteristics	The soil was obtained from a forested area with no cropping and pesticide application history
Length of experiment	4 months (first phase) + 4 months (second phase)
Age of plant at 1st exposure (seed, post-germination, mature)	Not reported in the publication
Initial contaminant concentration	Aroclor 1248 was added to soil at 100 mg kg-1 of soil.

Phytotechnologies application

Post-experiment plant condition	After four months the planted treatment had significantly lower levels of PCB (27 mg/kg) compared to the unplanted control pots (82 mg/kg). After 4 months of growth in the irradiated soil, planting resulted in a 70% biodegradation of the initial contaminant concentration. In the unirradiated soil only 23% of the initial PCB levels were recovered compared to 82% in the unplanted control. Moreover, statistically significant differences observed in soil Aroclor 1248 levels between planted and unplanted soils and lack thereof between the planted irradiated and unirradiated soils suggested that planting was the most important factor for a successful phytoremediation of PCB in soil.
Contaminant storage sites in the plant and contaminant concentrations in tissues (root, shoot, leaves, no storage)	No reported